Blahblah-

-The ride-

Objective

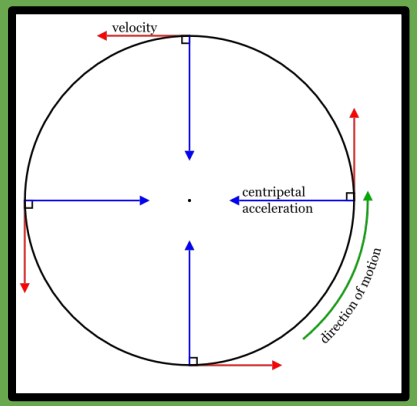
The objective of this project is to demonstrate the physics concepts; including work and energy, uniform circular motion, and electric circuit. This project will demonstrate all of the stated concepts by using two components of the amusement park, the roller coaster, which is named 'Blahblah-crash: the ride' and the LED sign.

note: In this demonstration, air resistance and friction are neglected in all calculations.

Uniform Circular Motion (UCM)

The circular motion is a motion of objects moving in a circular path. The objects are moving at constant speed as the velocity of the objects is parallel to their motion; however, there is an acceleration going towards the center of the path, called the centripetal acceleration.

$$a=v^2/r$$



WORK AND ENERGY

- There is work when a force is applied.
- Can either cause parallel or antiparallel motion on the object.
- If the object does not move, there is no work.
- Work done can be either positive or negative depending on the direction of the force applied and the object's motion.

Work done can be calculated by using the formula

$W = FS \cos$

where : W is work done (J)

F is force applied (N)

S is distance travelled by the object (m)

is the angle that the force make with the ground (degree)

WORK AND ENERGY

- Energy is required in order to do work.
- Two main types of energy are potential and kinetic energy.
- The object only contain GPE when it is static in the position that have height referring to the reference ground.
- The GPE of the object can be defined using the formula $E_p = mgh$ where: E_p is the gravitational potential energy
  M is the object's mass (Kg)
  G is the gravitational acceleration (m/s^2)
  H is the height of the object comparing to the referencing ground (m)

- Kinetic energy is another form of energy that exists when the object has motion only.
- KE of the object at any instant time can be defined using the formula $E_k = 1/2mv^2$ where: E_k is the kinetic energy
  M is the object's mass (Kg)
  V is the velocity (m/s)

WORK AND ENERGY

- PE and KE can be transferred between each one depending on its direction and position of motion.
- If the object is moving down the gravity, its PE is changing into the kinetic.
- If the object is moving up against the gravity, the KE is changed into the PE.

The law of conservation of energy: energy is always conserved if there is no non-conservative work acting on the system. Example of non-conservative work includes work done by air resistance and work done by friction.

Change in energy is also known as work done, as referred to the formula
$W = Ek$ or $W = Ep$

ELECTRICITY

- The Ohm's law:The potential different in a circuit is equal to the product of the electric current and the overall resistance of the circuit as stated in the formula V = IR where :
  - V is the potential different
  - I is the current flows in the circuit
  - R is the total resistance within the circuit

The circuit can be classified into parallel and series circuit which are differentiate by the way how the objects are connected.

ELECTRICITY

Series circuit:

- All the objects including resistors, cells, and electrical wires are connected in a cycle.
- The current passing through the whole circuit is said to be the same.
- The total potential difference and the total resistance is equal to the sum of all the potential different passing each resistors and the resistance itself respectively.
- "when one is out, the rest also out because of the incomplete circuit."

$V_{total} = V_1 + V_2 + V_3 + ...$

$R_{total} = R_1 + R_2 + R_3 + ...$

$I_{total} = I_1 = I_2 = I_3 = ...$

ELECTRICITY

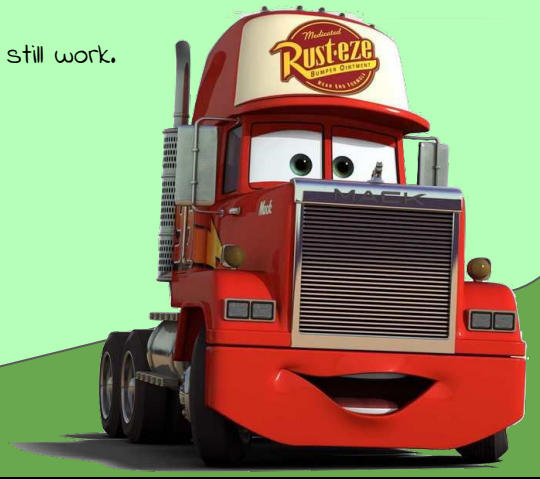
Parallel circuit:

- Each resistor is connected to a cell in different circuit; but still shared the same power source.
- The potential between each resistor is equal in all circuit.
- The inverse of total resistance is equal to that of each resistor.
- The total current is equal to the sum of a current of each circuit.
- The purpose of this kind of circuit is that when a resistor is out, the rest can still work.

$V_{total} = V_1 = V_2 = V_3 = \dots$

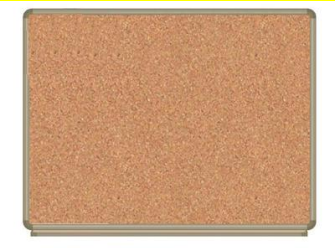
$\frac{1}{R_{total}} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \dots$

$I_{total} = I_1 + I_2 + I_3 + \dots$



MATERIALS

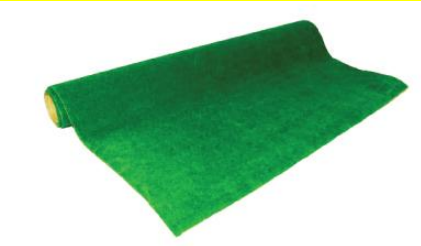
Wood board



Duct tape

Multimeter

Grass stickers



Scissor

MATERIALS

Toy car

Scissor

Hose

Hot melt glue gun

Clamps

Popsicle sticks

Cutter

Balsa wood

MATERIALS

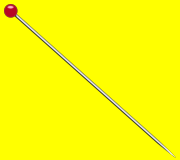
PP board

Lead solder

LED light

Battery

Pin



Switch

Battery holder

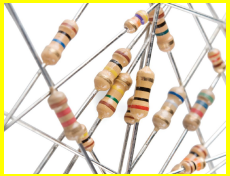
Wire

Cutter

Soldering iron

Ruler

Resistor



PROCEDURE

Ride

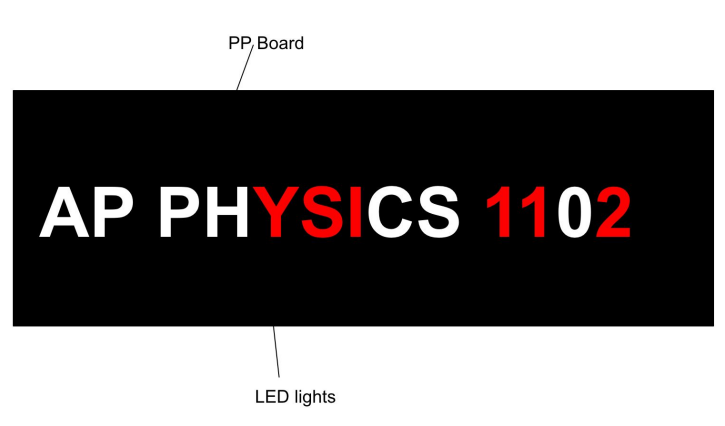
1) Plan the project based on the topics that we have learned throughout the whole year.
2) Design the project as a class, and decide which group will do which part of the project
3) Do the project separately as a group
4) Our group decides to do the roller coaster, so at first, we were deciding the materials that we want to use to make the project.
5) Buy the listed materials
6) Glue the popsicle sticks together to form beams in order to support the roller coaster track
7) Put the beam on the base, and glue it.
8) Put an aluminum clamp on top the beam to shape the pipe.
9) Fix the pipe in the middle of the clamp to put it into shape.
10) After the inclined part, curve the pipe and angle it to the angle that the car can travel through.
11) Test the track by dropping the car down the track, and see if it reach the target.
12) Put the switch at the end of the track, and drop the car along the track again, and see if the car could turn on the switch or not.
13) Stick the switch to the board at an angle so that the car would hit the switch
14) Drop the car, and let it slide down the track again to make sure that the car is able to go through the track and reach the target.

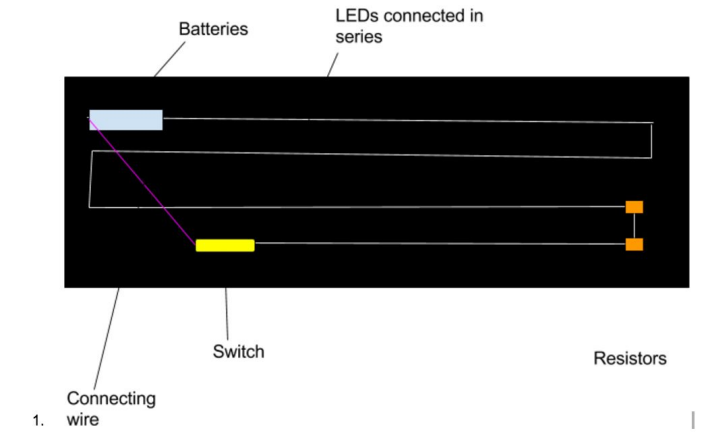
PROCEDURE

LED

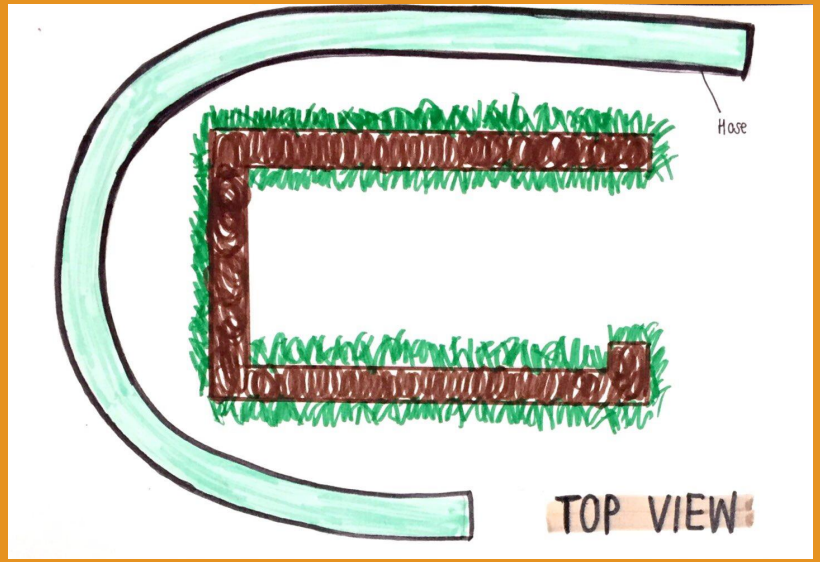
1) After planning, design the sign and estimate the amount of LED lights that would be used.
2) Cut the PP board to the desired size. The size of the board used in this project is 80 cm x 120 cm.
3) Poke the hole into the PP board where the LED lights will be placed by using the pin. This will allow the LED lights to poke through the board later on.
4) Put LED lights into the board. Bend the positive leg to the left and the negative leg to the right.
5) Complete the circuit by connecting the lights and the battery in series. Test whether if the lights work or not.
6) Secure the legs of the LED/diodes by soldering it.
7) Measure the resistance of two resistors.
8) Connect the LEDs to the two resistors in order to prevent the bulb from being burned out.
9) Connecting the circuit to the switch.
10) Secure all the wires with duct tape.

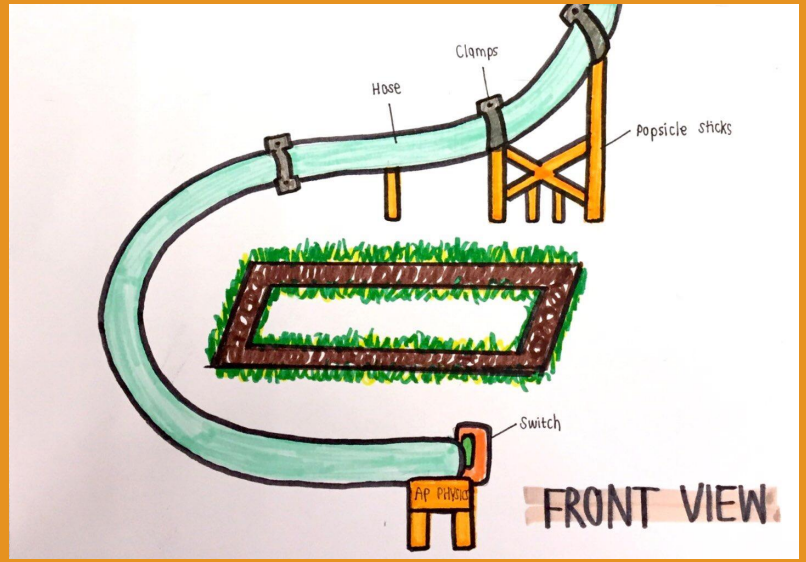
SET UP


PP Board
AP PHYSICS 1102
LED lights


Batteries
LEDs connected in series
Switch
Resistors
Connecting wire
1.

SET UP


Hose
TOP VIEW


Clamps
Hose
Popsicle sticks
Switch
AP Physics
FRONT VIEW

Discussion of Physics Concepts

- Work and energy
  - Track
- Circular motion
  - curve
- Electricity
  - LED light board

DISCUSSION OF DESIGN

- **The roller coaster track was made of the plastic watering pipe** as it has the smooth surface which means that there is very little amount of friction.
- **The track's height at the initial position** is calculated in order for the car to obtain enough energy to complete the track.
- **The curving part** was designed to form with the radius of 35 centimeters
- **The angle** that the track made with the ground is planned, so the car do not goes off the track.
- **The position and angle of the switch** is adjusted to enable the car to hit and turn on the switch, so the light is on.

DATA

Blahblah-Crash

Mass of cart = 35 g = 0.035 kg
Radius of path = 35 cm = 0.35 m
Height of the incline = 45 cm = 0.45 m

Conservation of Energy

$E_o = E_f$

$mgh = \frac{1}{2}mv^2$

$(9.8)(0.45) = \frac{1}{2}v^2$

$v^2 = 8.82\ (m/s)^2$

$v = \sqrt{8.82}$

$= 2.97\ m/s$

$a = \frac{v - v_o}{t}$

$= \frac{0 - 2.97}{1}$

$a = -2.97\ m/s^2$

Centripetal acceleration

$a_c = \frac{v^2}{r}$

$a_c = \frac{8.82^2}{0.45}$

$a_c = 172.87\ m/s^2$

$F = ma$

$= (0.035)(-2.97)$

$F = -0.10\ N$

Friction and air resistance were neglected in all calculations

DATA

LED sign

Resistors = 18Ω
Resistance of LED = 1.3Ω per LED
155 LEDs = (155)(1.3) = 201.5 Ω
Voltage = 9V

Ohm's Law

$V = IR$

$I = \frac{V}{R}$

$Power = \frac{V^2}{R}$

$P = \frac{9^2}{201.5+18}$

$P = 0.369\ W$

$= 369\ mW$

$V = IR$

$I = \frac{V}{R}$

$I = \frac{9}{18+201.5}$

$I = 0.0410\ A$

$= 41.00\ mA$

DATA - RIDE

Mass of the cart	0.035 kg
Initial height	0.45 m
Gravitational potential energy	0.15435 J
Kinetic energy	0.15435 J
Velocity squared	88.2 $(m/s)^2$
Radius of the track	0.35 m
Centripetal acceleration	196 m/s^2
Velocity	9.39 m/s
Acceleration (when hitting the switch)	-9.39 m/s^2
Force that the cart exerted on the switch	-0.33 N

DATA - LED SIGN

Resistance of resistors	18 ohm
Total voltage of the circuit	9V
Resistance of a LED	1.3 ohm
Resistance of all LEDs	201.5 ohm
Total resistance of the circuit	219.5 ohm
Current of the circuit	0.0410 A
Power of the LED	0.369 watts

ANALYSIS OF DATA

At the beginning, the car only has the gravitational potential energy of 0.1543 Joules as it is at the position of 45 centimeters above the reference ground. The energy is then converted to kinetic energy as the car moves down the inclined plane, and the energy is fully converted to kinetic energy when the car reaches the ground which makes the height zero. when the car travels to the curving part, it is travelling in the form of circular motion where the centripetal force of the motion is Nsin, and the curve is banked in order to prevent the car from going out from the track. After that, when the car travels to hit the switch, the velocity of the car becomes zero, and it exerts the force of 0.33 N on the switch to turn the switch on; therefore, it starts the domino effect by turning on 155 LED light bulbs in a circuit having the electric current of 42.25 mA and power of 380.3 mW as we have put the resistor with the resistance 18to decrease the power in the circuit, so the LED lights do not burn.

CONCLUSION

"The project demonstrate the physics concepts including work and energy, circular motion, and electricity. While the car is travelling down the incline plain, the potential energy stored is converted into kinetic energy dealing to the law of conservation of energy. After the car travels to the end of the track, it hits the switch and turn it on, so the circuit would be complete and the LED lights will be working. This shows the theory of electric series circuit."

RECOMMENDATION

- Time is needed.
- The friction between the wheel and the track and the friction between the wheel and the cart itself should be lessen by using some other materials.
- Other kind of material is more malleable could be used instead of the plastic hose in order to bend the track more to make sharp turns and make the ride more rollercoaster-like.
- The LED lights, LED light strips could be used for simplicity and other materials other than PP board might be used in order to strengthen the sign.

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